

Beverage Density and Percent Sugar

Sugar Content Analysis

Introduction

Have you ever been to the ocean? Does it seem that you can float or swim much easier in the ocean than in a swimming pool? Seawater is more dense than freshwater due to the presence of dissolved salt in the ocean. As a result, our buoyancy – ability to float – is greater in salt water than in plain water. What factors determine the density of a solution? Can the density of a solution be used to determine how much of a particular substance is dissolved in it?

Concepts

- Density
- Concentration
- Solution
- Calibration Curve

Background

The density of a pure substance is a characteristic physical property that can be used to identify the substance. *Density* is defined as the ratio of mass per unit volume. It is an “intensive” property, that is, it does not depend on the amount of the substance. The density of any material is determined by measuring its mass and volume and then dividing the mass by the volume. The mass of a substance can be measured directly using a balance. The volume of a liquid can also be measured directly using special laboratory glassware, such as a graduated cylinder, a buret, or a pipet. In this experiment, liquid volume will be measured using a pipet. A pipet is designed to deliver an accurate and precise volume of liquid to another container.

The density of a *solution* depends on its *concentration*, that is, how much solute (solid) is dissolved in the solvent (liquid). The higher the concentration of solute, the greater the density of the solution. A convenient way to express concentration is in units of mass percent, which corresponds to the number of grams of solute that are present in 100 g of solution.

$$\text{Mass \%} = \frac{\text{mass of the solute (sugar)}}{\text{Mass of the solution (solute and solvent)}} \times 100$$

For example, a 20% salt solution is prepared by dissolving 20 g of sodium chloride in 80 g of water. (Notice that the final mass of the solution is 100 grams.) If the density of a solution is plotted on a graph against the concentration of solute, a regular pattern is evident. Density is directly proportional to concentration. A 20% salt solution, for example, has a greater density than a 10% salt solution. If the densities of several solutions of known concentration are determined experimentally, a *calibration curve* (graph) can be constructed that shows a straight-line relationship between the density of a solution and the concentration of solute. The calibration curve can then be used to find the concentration of solute in an unknown solution by knowing its density.

Materials

Distilled water
 Beverages (Coke, Sprite and Mountain Dew)
 Sugar reference solutions
 Balance, centigram (0.01 g precision)
 Beaker, 250-mL
 Erlenmeyer flask, 125-mL (to collect rinse solutions)
 Pipet, 5-mL
 Pipet bulb

Laboratory Technique

The pipets used in this experiment are designed to accurately deliver 5.00 mL of liquid from one container to another.

Fill the pipet to the graduation mark. Remove the pipet from the liquid container and wipe the sides of the pipet only with a clean paper towel. Do not blot the tip of the pipet. To transfer the liquid, place the pipet in the new container. Holding the pipet at a slight angle, allow the liquid to drain slowly into the container. **Never pipet by mouth.**

